Summary: P193 #9-26

9) The question asks for an estimate, so no direct calculation will be used.
Naturally occurring argon is made of almost exclusively Ar-40, specifically 99.66%. The lighter isotopes of argon, Ar-36 and Ar-38 make such a small proportion of naturally occurring argon that they can be ignore for the purposes of estimating an average atomic mass. Therefore, naturally occurring argon would have an average atomic mass of about 40 amu. The true average atomic mass would be slightly smaller than 40.

10) The question asks for an estimate, so no direct calculation will be used.
Naturally occurring gallium is made of two isotopes, Ga-69 and Ga-71 in close to equal proportions, 60% and 40% respectively. Therefore, the average atomic mass of naturally occurring gallium will have an average atomic mass close to 70, but slightly smaller, since there is more Ga-69 than Ga-71.

11) The question asks for an estimate, so no direct calculation will be used.
Naturally occurring germanium is mostly Ge-70, Ge-72 and Ge-74 in close to equal amounts, 20.5%, 27.4% and 36.5%. For the purposes of estimating, the low amounts of Ge-73 and Ge-76 will be ignored. The average atomic mass of naturally occurring germanium will be close to 72, the average of 70, 72 and 74. It will be slightly higher than 72, but less than 73, due to the slightly higher amount of Ge-74.

12) Let 'x' be the abundance of K-39. Therefore, the abundance of K-41 is 1-x.
$39.10 = x(39) + (1-x)(41)$
$39.10 = -2x + 41$
$2x = 1.90$
$x = 0.95$
Therefore, naturally occurring potassium is 95% K-39 and 5% K-41.

13)
a) $M(Fe_2O_3) = 159.70$ g/mol
$n(Fe_2O_3) = 0.453 \text{ g} \div 159.70 \text{ g/mol} = 0.00284 \text{ mol}$

b) $M(H_2SO_4) = 98.09$ g/mol
$n(H_2SO_4) = 50.7 \text{ g} \div 98.09 \text{ g/mol} = 0.517 \text{ mol}$

c) $M(Cr_2O_3) = 152.00$ g/mol
$n(Cr_2O_3) = 0.0124 \text{ g} \div 152.00 \text{ g/mol} = 8.16 \times 10^{-5} \text{ mol}$

d) $M(C_2Cl_3F_3) = 87.37$ g/mol
$n(C_2Cl_3F_3) = 0.082 \text{ g} \div 87.37 \text{ g/mol} = 9.4 \times 10^{-4} \text{ mol}$

e) $M(NH_4Br) = 97.95$ g/mol
$n(NH_4Br) = 12.3$ g ÷ 97.95 g/mol = 0.126 mol

14)
a) $n(He) = 4.27 \times 10^{21}$ atoms ÷ 6.02×10^{23} atoms/mol = 7.09×10^{-3} mol
b) $n(ICl) = 7.39 \times 10^{23}$ molecules ÷ 6.02×10^{23} molecules/mol = 1.23 mol
c) $n(NO_2) = 5.28 \times 10^{22}$ molecules ÷ 6.02×10^{23} molecules/mol = 0.0877 mol
d) $n[Ba(OH)_2] = 2.91 \times 10^{23}$ formula units ÷ 6.02×10^{23} formula units/mol = 0.483 mol
e) $n(KI) = 1.62 \times 10^{24}$ formula units ÷6.02×10^{23} formula units/mol = 0.269 mol
f) $n(C_3H_3) = 5.58 \times 10^{20}$ molecules ÷ 6.02×10^{23} molecules/mol = 9.27×10^{-4} mol

15) Answers are in red

Sample	M (g/mol)	m (g)	N (particles)	n (mol)	n of atoms (mol)
NaCl	58.4	58.4	6.02×10^{23}	1.00	2.00
NH_3	17.04	24.8	8.79×10^{23}	1.46	5.84
H_2O	18.02	1.58	5.28×10^{22}	0.0877	0.263
Mn_2O_3	157.88	10.5	4.00×10^{22}	0.0664	0.332
K_2CrO_4	194.20	9.67×10^{-1}	3.00×10^{21}	0.00498	0.0349
$C_8H_8O_3$	152.16	1.99×10^{3}	7.90×10^{24}	13.1	49
$Al(OH)_3$	78.01	6.66×10^{4}	5.14×10^{26}	8.54×10^{2}	5.98×10^{3}

16)
a) $M(PtBr_2) = 354.88$ g/mol
b) $M(C_3H_5O_2H) = 74.09$ g/mol
c) $M(Na_2SO_4) = 142.05$ g/mol
d) $M[(NH_4)_2Cr_2O_7] = 252.10$ g/mol
e) $M[Ca_3(PO_4)_2] = 310.18$ g/mol
f) $M(Cl_2O_7) = 182.90$ g/mol

17)
a) $M(H_2O) = 18.02$ g/mol
$m(H_2O) = 3.70$ mol X 18.02 g/mol = 66.7 g
b) $M(PbO_2) = 239.20$ g/mol
$n(PbO_2) = 8.43 \times 10^{23}$ formula units ÷ 6.02×10^{23} formula units/mol = 1.40 mol
$m(PbO_2) = 1.40$ mol X 239.20 g/mol = 335 g
c) $M(BaCrO_4) = 253.33$ g/mol
$m(BaCrO_4) = 14.8$ mol X 253.33 g/mol = 3.75×10^{3} g

d) $M(Cl_2)$ = 70.90 g/mol
$n(Cl_2)$ = 1.23 X 10^{22} molecules ÷ 6.02 X 10^{23} molecules/mol = 0.0204 mol
$m(Cl_2)$ = 0.0204 mol X 70.90 g/mol = 1.45 g
e) M(HCl) = 36.46 g/mol
n(HCl) = 9.48 X 10^{23} molecules ÷ 6.02 X 10^{23} molecules/mol = 1.57 mol
m(HCl) = 1.57 mol X 36.46 g/mol = 57.2 g
f) $M(Fe_2O_3)$ = 159.70 g/mol
$n(Fe_2O_3)$ = 7.74 X 10^{19} formula units ÷ 6.02 X 10^{23} formula units/mol = 1.29 X 10^{-4} mol
$m(Fe_2O_3)$ = 1.29 X 10^{-4} mol X 159.70 g/mol = 0.0206 g

18) $M(C_6H_6)$ = 78.12 g/mol
$n(C_6H_6)$ = 45.6 g ÷ 78.12 g/mol = 0.584 mol
There are 6 carbon atoms per molecules of C_6H_6
therefore, n(C) = 6 X 0.584 mol = 3.50 mol
N(C) = 3.50 mol X 6.02 X 10^{23} atoms / mol = 2.11 X 10^{24} atoms

19) There are 3 atoms of F in every molecule of BF_3; therefore,
n(F) = 3 X 0.72 mol = 2.2 mol
N(F) = 2.2 mol X 6.02 X 10^{23} atoms/mol = 1.3 X 10^{24} atoms

20)
a) m(Xe) = 131.29 u/atom
b) m(Xe) = 1.00 mol X 131.29 g/mol = 131.29 g
c) m(one Xe atom) = 131.29 g/mol ÷ 6.02 X 10^{23} atoms/mol = 2.18 X 10^{-22} g/atom
d) m(one mole Xe) = 131.29 u/atom X 6.02 X 10^{23} atoms/mol = 7.90 X 10^{25} u/mol
e) m(in u/g) = 7.90 X 10^{25} u/mol ÷ 131.29 g/mol = 6.02 X 10^{23} u/g

21)
Number of C atoms in the CO_2:
$N(CO_2)$ = 0.237 mol X 6.02 X 10^{23} molecules/mol = 1.43 X 10^{23} molecules
There is one C atom per molecule of CO_2, therefore:
N(C from CO_2) = 1.43 X 10^{23} atoms
Number of C atoms in the CaC_2:
$N(CaC_2)$ = 2.38 mol X 6.02 X 10^{23} formula units/mol = 1.43 X 10^{24} formula units
There are 2 C atoms per formula unit of $CaC_{2,}$ therefore:
N(C from CaC_2) = 2.86 X 10^{24} atoms
Total number of C atoms = 1.43 X 10^{23} atoms + 2.86 X 10^{24} atoms = 3.00 X 10^{24} atoms

22)
Number of H atoms in H_2O:
There are 2 atoms of H in each molecule of H_2O, therefore:
N(H from H_2O) = 6.98×10^{23} atoms
Number of H atoms in CH_3OH
M(CH_3OH) = 32.05 g/mol
n(CH_3OH) = 78.1 g ÷ 32.05 g/mol = 2.44 mol
N(CH_3OH) = 2.44 mol X 6.02×10^{23} molecules/mol = 1.47×10^{24} molecules
There are 4 atoms of H in each molecule of CH_3OH, therefore
N(H from CH_3OH) = 5.88×10^{24} atoms
Total number of H atoms = 6.98×10^{23} atoms + 5.88×10^{24} atoms = 6.58×10^{24} atoms

23)
n[$Ca(NO_3)_2$] = 3.76×10^{-1} mol X 6.02×10^{23} formula units/mol = 2.26×10^{23} formula units
There are 2 NO_3^- ions per formula unit of $Ca(NO_3)_2$, therefore:
n(NO_3^-) = 4.52×10^{23} ions.

24)
M(C_2H_5OH) = 46.08 g/mol
n(C_2H_5OH) = 92.0 g ÷ 46.08 g/mol = 2.00 mol
Since 3 molecules of O_2 are needed to react with each molecule of C_2H_5OH, therefore
n(O_2) = 6.00 mol
M(O_2) = 32.00 g/mol
m(O_2) = 32.00 g/mol X 6.00 mol = 192 g

25)
Let x = the abundance of Br-79; therefore the abundance of Br-81 is 1-x
average atomic mass of Br = 79.90
79.90 = x(79) + (1-x)81
79.90 = 79x + 81 - 81x
2x = 1.10
x = 0.55
Therefore, naturally occurring bromine is 55% Br-79 and 45% Br-81

26)
a) From the BCE, NaCl and $AgNO_3$ react in a 1:1 ratio. Therefore 1 mol of NaCl will react with 1 mol of $AgNO_3$
b) M(NaCl) = 58.44 g/mol
n(NaCl) = 29.2 g ÷ 58.44 g/mol = 0.500 mol
Therefore, n($AgNO_3$) = 0.500 mol (recall: they react in a 1:1 mole ratio)
M($AgNO_3$) = 169.88 g/mol
m($AgNO_3$) = 0.500 mol X 169.88 g/mol = 84.9 g